METHODS OF ANESTHESIA FOR COMPLICATED OBSTETRICS*

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DIFFERENCES in anesthetic management required between vaginal and abdominal delivery are never more important than in the presence of complications. Segmental lumbar extradural (epidural, peridural) block is the optimal method for vaginal delivery in most abnormal situations, but general anesthesia may be safer for cesarean section because of the risks accompanying more extensive levels of regional blockade.

ANESTHETIC REQUIREMENTS AND COMPLICATIONS

Different levels of sensory analgesia are required for pain relief during labor, vaginal delivery, and cesarean section. Pain during the first stage of labor is caused by the uterine contractions that produce cervical dilation. The sensation is transmitted by small fibers that follow the sympathetic nerves to their origins in the spinal ganglia of the 10th thoracic through 1st lumbar segments, and the pain is alleviated by a segmental low-thoracic extradural block via the lumbar route or by a paracervical block. The latter, however, has been associated with a high incidence of fetal bradycardia, most likely related to decreased fetal oxygenation secondary to an increase in uteroplacental vascular resistance.[1] Use of paracervical block is, therefore, potentially harmful and is contraindicated whenever impairment of uteroplacental circulation is suspected. Pain impulses during the second stage of labor are initiated by distention of the lower birth canal and perineum and are conducted by the pudendal nerves to the 2nd through 4th sacral segments. They can be relieved by low extradural block

*Presented before the Section on Obstetrics and Gynecology of the New York Academy of Medicine November 8, 1980.

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via either the lumbar or caudal route, by low spinal block, or by pudendal block. Maternal and fetal blood levels of local anesthetic drugs during the second stage of labor were found to be similar following continuous segmental lumbar extradural block and following pudendal block despite more prolonged duration of pain relief with the former.[2,3] It is, therefore, most rational to extend a catheter-induced extradural block begun during the first stage by adding additional drug with the parturient sitting during injection and for three minutes thereafter. By providing two separate segments of analgesia, the dose of local anesthetic is reduced so that less drug is presented to the placenta for transfer to the fetus. The extent of motor blockade is minimized so that motion of the legs and ability to bear down are not affected. Likewise, the degree of sympathetic involvement is decreased, particularly because the sacral innervation does not include sympathetic nerves. For this reason, significant arterial hypotension is not often a problem if the uterus is shifted away from the great pelvic vessels.

In contrast, cesarean sections require an anesthetic level to the sixth or even fourth thoracic segment. Such a high level of analgesia is associated with nearly total sympathetic blockade and, thus, inhibition of the capacity for compensatory vasoconstriction. Hence, marked falls in blood pressure have been reported during abdominal deliveries, under both spinal and extradural analgesia.[4,5] However, Wollman and Marx[6] have demonstrated that the intravenous infusion of one liter of balanced electrolyte solution prior to administration of high regional analgesia prevents the development of hypotension in women whose uteri are displaced prophylactically and that the same volume of solution is useful in reversing hypotension following regional block in nonprehydrated controls. Prevention and treatment of the hypotension of high spinal or extradural analgesia should therefore be designed primarily to increase effective circulating blood volume. A small intravenous dose of a vasopressor with predominantly central (cardiac) action, e.g., ephedrine, may be employed safely in addition, but without adequate hydration ephedrine is not effective even in larger doses.[7] It follows that regional analgesia is not the method of choice for cesarean section for parturients who cannot tolerate an acute increase in circulating blood volume or cardiac output (e.g., cardiac disease, severe chronic anemia), for women in whom the urgency of the situation does not allow time for adequate hydration, and for gravidae who may not respond to the outlined regimen because of blood loss or large doses of antihypertensive drugs.

The extensive motor blockade associated with high regional analgesia produces respiratory difficulty more readily among pregnant women than nonpregnant patients because of anatomic alterations in the thoracic cage and functional changes in ventilation which develop during the course of pregnancy. Parturients with weakness of the respiratory muscles are, therefore, unsuited for high regional analgesia.

In addition, regional analgesia of any extent is contraindicated in the presence of a bleeding diathesis to prevent formation of an extradural hematoma and in septicemia to avoid development of meningitis. In contrast, psychosis, neurologic disease, and hypertension are by themselves no longer considered absolute contraindications.

Common complications of general anesthesia include difficulty in endotracheal intubation and pulmonary aspiration of gastric contents; both lead to maternal—and consequently fetal—hypoxia, hypercarbia, acidosis, and possibly death. There are, however, situations in which the choice of regional versus general anesthesia is not clear-cut, and the advantages and disadvantages of either method must be considered on an individual basis.

Mitigation of the Physiologic Responses to the Pain of Labor

Benefits of segmental lumbar extradural block for vaginal delivery apply to both mother and infant. Labor is a stressful, energy-consuming process associated with marked circulatory, respiratory, and metabolic responses.[8-10] Augmented catecholamine output may decrease uteroplacental blood flow and result in fetal deterioration as evidenced by bradycardia and acidosis.[11] However, both maternal and fetal reactions can be reduced when pain is relieved.[8-11] Of the various types of analgesia, i.e., parenteral narcotics, self-inhaled nitrous oxide, and segmental extradural block, the latter has consistently produced the best overall results. Thus, excess lactate production during the course of labor was approximately 50% less with pain relief by extradural block than with parenteral medication.[10] Similarly, a respiratory minute volume of 14 l./minute during contractions of the first stage was decreased only slightly after meperidine, 50 mg. intravenously, but was reduced to 10 l./minute following induction of segmental extradural block.[9] In contrast, self-administered nitrous oxide analgesia has been associated with minute volumes of up to 80 l./minute.[12] Abnormally high respiratory minute volumes increase the mother's oxygen consumption, decrease her alveolar and arterial carbon dioxide tensions, and cause respiratory alkalosis. Increased oxygen consumption may lead

to a severe oxygen debt, while hypocarbia may cause vasoconstriction of the cerebral and possibly the uteroplacental vasculature. Most important, alkalemia rapidly shifts the oxygen-dissociation curve to the left, thereby impairing the release of oxygen to maternal tissues and fetal blood. When healthy parturients hyperventilated voluntarily for five minutes, the oxygen tension of fetal scalp capillary blood declined 3 mm. Hg ($p < 0.01$).[13] Neurobehavioral tests of neonates have revealed significant reductions in the percentage of high scores, on both the first and second days of life, when meperidine had been administered to the mother during labor.[14] Segmental lumbar extradural block, in contrast, has been associated with the greatest percentage of high scores, most notably for overall assessment, alertness, and sucking.[15]

Medical Complications

Preeclampsia, the most frequent medical complication of pregnancy, is characterized by three basic pathologic mechanisms: generalized arteriolar vasoconstriction with resultant decrease in blood flow; retention of water and sodium in excess of that during normal gestation; and disturbance of the balance between coagulation and fibrinolysis. Decreased perfusion of kidneys and the uteroplacental unit impairs the function of both organs.[16,17] Accumulation in edematous tissues of extracellular extravascular fluid with normal electrolyte compositions results in hypovolemia and hemoconcentration documented by laboratory data as well as by central venous pressure measurements.[18,19] The accompanying hypoproteinemia is due both to shift of protein into the extracellular compartment and loss from the urine. Plasma fibrinogen and plasminogen levels are, in general, within the lower ranges of normal pregnancy, but platelet counts are decreased, and thrombin and prothrombin times may be prolonged.[20] Correction of hypovolemia must be started before the institution of anesthesia. Balanced electrolyte solution or colloid plasma expanders, or both, must be administered intravenously to raise central venous pressure to between 6 and 8 cm. H_2O. The higher the diastolic arterial pressure, i.e., the more severe the disease, the lower will be the central venous pressure and the larger the volume of intravenous fluid needed. Addition of a colloid plasma expander to electrolyte solutions has been reported to be most beneficial: circulating blood volume increased readily, depleted protein was replaced, placental perfusion and urine output improved, and diastolic pressure and edema declined.[18,19]

For labor and vaginal delivery, lumbar extradural block has been recognized as the anesthetic method of choice, provided the platelet count is at least 100,000/mm^3. With sufficient hydration and adequate uterine displacement, hypotensive complications have all but disappeared despite use of antihypertensive drugs.[19,21] Specific advantages of regional blockade are threefold. First, arterial pressure can be lowered gradually and judiciously so that the dosage of systemic antihypertensives can be decreased.[21] Second, circulatory, respiratory, metabolic, and adrenal hormonal responses to uterine contractions are mitigated.[8-11] Third, the incidence of eclamptic convulsions and duration of postictal coma seem to be markedly reduced.[22]

For cesarean section, regional analgesia is also preferable if hydration has been adequate. In a recent study of 20 severely preeclamptic women requiring cesearean section, 10 received general anesthesia and 10 lumbar extradural analgesia. The group with general anesthesia had a mean increase in mean arterial pressure of 45 mm. Hg, in pulmonary artery pressure of 20 mm. Hg, and in pulmonary capillary wedge pressure of 20 mm. Hg during endotracheal intubation and extubation. In contrast, parturients who received regional analgesia had little change in these cardiovascular variables apart from a slight mean fall in mean arterial pressure.[23] It must also be considered that magnesium sulfate potentiates all muscle relaxants used in general anesthesia, and often unavoidably prolongs the recovery period.[24]

Proper anesthetic care of diabetic parturients begins with rational fluid and insulin therapy and frequent blood glucose measurements to maintain the plasma glucose concentration at approximately 100 mg./dl.[25] Optimal anesthetic management avoids agents and techniques that tend to aggravate preexisting disturbances in glucose and acid-base metabolism, increase endogenous catecholamine output, or necessitate neonatal degradation of large amounts of placentally-transferred drugs. Regional analgesia is essential for labor and vaginal delivery. Advantages for mothers include reduced metabolic expenditure, a low incidence of vomiting, and the ability to return to oral food intake shortly after delivery. The advantage to infants lies in absence of central nervous system depression. Cesarean sections may be managed with spinal or lumbar extradural block or with balanced endotracheal anesthesia. Prevention of hypotension following regional block may be more difficult to achieve than in nondiabetic parturients, and use of an electrolyte solution with 5% albumin offers

special advantages because colloid solutions reduce the disparity between the volume and capacitance of the vascular system more effectively than conventional crystalloid solutions.[26]

Anesthetic management of gravidae with sickle cell disease should avoid hypoxemia, acidemia, and dehydration before, during, and after anesthesia. Regional analgesia is the method of choice for both vaginal and abdominal delivery because the risk of hypoxemia associated with general anesthesia during induction and recovery is avoided. In addition, exertion during labor is prevented most effectively. Inhalation of oxygen by face shield or nasal cannulae is essential, and intravenous hydration should be generous enough to avoid stasis.[27]

The incidence of heart disease among pregnant women has declined as a result of operative correction and better prevention of rheumatic fever. Optimal anesthetic management for vaginal delivery of gravidae with functional cardiac disease mitigates the strain placed on the heart by labor. The following measures are recommended for labor and delivery: relief of stress and apprehension by administration of a tranquilizer during early labor, complete relief of pain and abolition of bearing-down efforts by regional analgesia, preferably double-segmental lumbar extradural block, and continuous inhalation of oxygen. Only when anticoagulation cannot be adequately reversed is administration of extradural or spinal block contraindicated. Cesarean sections, on the other hand, are best performed under general anesthesia because prevention of postregional block hypotension by fluid preloading may be difficult to achieve. In the choice of intravenous induction and inhalation agents, those that depress the myocardium or induce hypotension should be avoided.[28]

For parturients with chronic bronchitis, bronchial asthma, or both, regional analgesia is optimal because further interference with affected respiratory function is avoided and the most common single factor that precipitates an attack of wheezing during general anesthesia is an endotracheal tube.[29]

Most gravidae with a previous subarachnoid hemorrhage or proved intracranial vascular anomaly are delivered vaginally because cesarean section offers no special advantages. The second stage of labor should be short and delivery accomplished without strenuous bearing-down efforts. The most rational anesthetic method for vaginal delivery, again, is continuous extradural block while cesarean section may be performed with either regional or balanced endotracheal anesthesia.[30]

Obstetric Complications

The circulatory effects of hemorrhage not only endanger the mother but compromise the ability of the placenta to sustain the fetus because severe blood loss reduces the oxygen-carrying ability of the blood. Replacement by fresh blood or packed cells diluted in a crystalloid solution is advocated to increase the circulating red cell mass, and central venous pressure monitoring helps to guide the rate and amount of transfusion. In the anesthetic management, any insult added by drug or technique must be avoided. Therefore, regional analgesia is, in the main, not recommended. Instead, general endotracheal anesthesia is indicated, employing oxygen with a low concentration of an inhalation agent that maintains circulatory homeostasis; halothane and enflurane fulfill these requirements.[31]

Multiple pregnancies and breech presentations require effective bearing-down efforts for safe vaginal delivery. If segmental extradural anesthesia is instituted during the first stage, the parturient will reach the second stage in better physiologic condition than with other methods of pain relief, and will be able to cooperate to the fullest. At the same time, infants are spared the effects of central nervous depressant drugs. Blockade of sacral innervation may be withheld until shortly before delivery and may then be achieved with a local anesthetic that produces profound relaxation of the muscles of the perineum.[32,33] If cessation of uterine activity should be needed for internal version of a second or third baby or for breech extraction, a halogenated inhalation agent may be safely added to the regional block through an endotracheal tube. All halogenated agents as well as diethyl ether depress uterine activity in a dose-dependent manner. In clinical practice, halothane seems to be the most suitable agent because of its rapid onset of action and prompt reversibility.

A preterm fetus also benefits from regional analgesia. Because of its fragile dura mater and insufficiently calcified bones, the baby is at risk of intracranial hemorrhage during spontaneous vaginal delivery, so a well-controlled delivery without extensive bearing-down efforts by the mother is preferred. A preterm infant is also markedly sensitive to the adverse effects of maternal stress on uteroplacental perfusion and to the depressant properties of placentally-transmitted drugs, both systemic and local. In general, segmental lumbar extradural block is optimal for labor and vaginal delivery, and spinal block is preferable for cesarean section.[33]

When fetal distress necessitates prompt delivery, time should not be wasted in an attempt to establish extradural analgesia but if a catheter had

been introduced earlier, the block should be extended using a local anesthetic with rapid action. Spinal block, administered in the sitting position, can be accomplished rapidly and requires a minimum quantity of local anesthetic. General endotracheal anesthesia may provide operating conditions even more expeditiously but should not be used if there are such maternal contraindications as a "full stomach," asthmatic attack, or probable difficulty in placing the endotracheal tube. Whichever method of anesthesia is employed, high maternal oxygen inhalation is essential and any increase in fetal oxygenation, however slight, may be beneficial.[34]

CONCLUSIONS

Segmental lumbar extradural analgesia has evolved as the anesthetic method of choice for labor and vaginal delivery in most medical and obstetric complications. This recent development is due to advances in the treatment of the underlying pathophysiologies and to ability to forestall significant hypotension following lumbar block. Regional analgesia is also used with increasing frequency for cesarean section in many complications, although the contraindications exceed those for vaginal delivery. Regional anesthesia offers both physiologic and psychologic advantages, and giving parents an opportunity to experience the birth of their baby may, in fact, be more important in the presence of complications than in normal cases.

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